THURSDAY, APRIL 5, 1877

THE GEOLOGICAL SURVEY OF OHIO

Report of the Geological Survey of Ohio. Vols. I. and II. Geology, and I. and II. Palæontology. (Columbus, Ohio : Nevins and Myers, State Printers, 1873-5.)

IN the reports of American Scientific Surveys we have become accustomed to find that the results are as new and interesting as the methods of working are original and ingenious. Few of the States are more richly endowed with the elements of prosperity and stability than Ohio, and yet she has but recently come into the field with her contribution to the knowledge of her own geological structure and natural history. It is gratifying to know that this contribution can well afford to be tried by the high standard attained by the reports already issued by many of the neighbouring States.

The survey just completed is technically the second but practically the first geological survey of Ohio, taking into consideration how long ago the former survey was disbanded, and how short was its term of life.

In 1836 the legislature appointed a committee consisting of Dr. Hildreth, Dr. Locke, Prof. Riddell, and Mr. Lapham, to report on the best method of obtaining a complete geological survey of the State, and to estimate the probable cost. In the summer of that year three of these gentlemen made reconnaissances, while the fourth analysed iron ores and limestones. A year after the appointment of the committee, the legislature, on its recommendation, created a geological corps, comprising a state geologist (Prof. W. W. Mather) and six assistants. During the summer of 1837, the State geologist and three assistants prosecuted geological explorations, two assistants being absorbed by zoology and topography. Next summer the survey was continued on a similar footing, but a financial panic having broken out, "the legislature of 1838-39 made no appropriation for the continuation of the geological survey, and it was at once suspended." In spite of the disadvantages under which this early survey laboured in being almost entirely without palæontological assistance, its two annual reports were much appreciated, and the short-sighted economy that led to its disbandment was soon regretted by the citizens of the State. Although several attempts were made, what with the defalcations of a State treasurer, the building of a costly state-house, and the great Civil War, Ohio was not financially in a position to re-establish a geological survey till the year 1869.

According to its constitution, this new survey was to be begun (and was begun) on June 1, 1869, and was to be finished in three years. It was required "to make a complete and thorough geological, agricultural, and mineralogical survey of each and every county in the State." To the chief geologist the act of legislature allowed three assistants, and a number (generally eight or nine) of temporary local assistants were employed and paid from a fund provided for "contingent expenses." One of the assistant geologists was to be a chemist. We can see in the organic law of the survey no provision for a palæontologist, and presume that the appointment of that officer was authorised by one of the subsequent Acts of Appropriation. At any rate, Prof. J. S. Newberry, having been appointed chief geologist, conjoined with himself two assistants, a palæontologist and a chemist, and it can hardly be disputed that this was the best possible disposition of his forces, however desirable a large increase in the number of assistants might have been.

Such then is the scale on which a State, having an area of 39,904 square miles, plans its geological survey. Considering the number of working days in a year, the number of the field geologists, and the area of the State, many will not hesitate to decide that the character of a reconnaissance was stamped on the survey by its framers from the beginning. But it should not be forgotten that there are circumstances which render the geological mapping of Ohio exceptionally simple. The Palæozoic rocks which form its framework are so undisturbed, that over areas of sometimes thousands of square miles, only one formation makes its appearance at the surface, and outcrops are therefore little more than contour lines. We are accustomed in this country to think of "dip" as something visible to the naked eye, and measurable with a pocket clinometer ; and as producing, by its relation to the contour of the ground, endless variety in our geological boundary-lines. In Ohio it appears that the method of ascertaining the degree of dip is to set up half a dozen or so of trigonometrical stations, several miles apart, and carefully take the levels of the outcrop at the several points. So far as we have noted in reading the Reports, there is not a dip in the whole state that would make an appreciably stiff railway gradient. Then we are informed by Prof. Newberry that "faults in which the displacement amounts to more than one foot are very rare in the Ohio Coal-field," and that the greatest known has a down-throw of 3 feet. In Europe the complications produced by faults frequently add the excitement of a puzzle to the labours of the field-geologist and just as often leave an irritating element of uncertainty to embitter the satisfaction with which he is apt to regard his finished work. Then again there are no igneous rocks in Ohio and no metamorphic rocks in the ordinary sense of the term. Indeed it may almost be said that over large tracts there are no rocks at all. Thus in one county, "consisting of twelve towns," *i.e.* 432 square miles—exactly the area, let us say for comparison's sake, of a whole sheet of the 1-inch Ordnance Map of Scotland—the rock is deeply covered with drift and is never seen, having been reached by boring at one point only, at a depth of 110 feet.

On the other hand, the very simplicity of the geology of the State makes it a typical region by which other lands may measure their geological scale, and on this account it becomes necessary to survey it with minuteness and care. If Ohio renders this service to the neighbouring states, each of these has already given an equivalent. As it happened, when the late survey was begun, Ohio was almost surrounded by a belt of states which had got ahead of her in the work, and whose completed labours greatly simplified her task, at the same time that they presented discrepancies which could only be reconciled on her neutral ground.

Although it was originally intended that the survey should be finished in three years, its field work lasted for five, the average annual cost being $17,355.

We have now before us a portion of the final Reports or the Survey. These consist of two volumes of Geology, two of Palæontology, and two of Sheets of Vertical Sections (a sheet of Vertical Sections, by the way, is called a "Map" in the American language). Besides these there have already been published three volumes of Annual Reports of Progress, two of them containing Accounts of the Geology of Counties, in substantially the same form as that followed in the Final Reports. A third volume of Geology, to comprise by far the most important counties in the coal-field, is ready for publication and "awaits the action of the Legislature." "The matter for the third volume," says Prof. Newberry, "has been, to a considerable extent, prepared since the appropriations for the salaries of the geological corps were discontinued. Much of it is, therefore, a gratuitous contribution with which the corps should be credited when a comparison is made between the value of their services and the compensation they have received." Materials for a third volume of Palæontology have been accumulated, but the chief geologist does not speak confidently of his chances of getting a grant to defray the cost of its publication. It would be a thousand pities that the State which has been at the expense of collecting this information should not secure the credit and advantages involved in its official publication. Otherwise, the materials will have to be hunted through the transactions of American and foreign societies, and will be as good as half lost.

A volume on Economic Geology is far advanced, but six months' time and from $4,000 to $5,000 are estimated as necessary to complete it. A volume on the Zoology and Botany of the State is also ready for publication at a trifling expense.

Lastly, "a general geological map of the State can be prepared at a cost not greater than $1,500."

It will thus be seen that there still remain to be published some of the absolutely essential parts of the work of the survey. For scientific purposes the geological map stands first in point of necessity. It is not too much to say that it is chiefly by its general geological map that the survey will be known and judged abroad. It is indeed possible to construct a sort of geological map from the county and other sketch maps and information scattered through the volumes, and the writer has done so for his own satisfaction and as a means of mastering the Reports. But we can affirm with confidence that this is a labour that few will undertake, and which it would be much better that the officers of the Survey should perform once for all. The county maps, as will readily be understood from what has been said about the undisturbed condition of the rocks, are simplicity itself, being generally rectangles, crossed on an average by three boundary-lines inclosing four dabs of colour. But the general map will doubtless contain outcrops of coal and ironstone seams, the positions of oil and brine wells, fossil localities, and numerous other details, whose bearings can only be properly estimated when seen in the mass, or which it is the function of a geological survey to record, since for economic purposes the registration of all mining enterprises, whether failures or successes, is of permanent value. In her own interests we cannot doubt that the State will at once provide for the publication of the volume on Economic Geology, depending as she does to a large extent at present, and as she is certain to do still more in the not very distant future, on her mining industries.

If we may judge of the promised volumes on Palæontology, Zoology, and Botany from the results already before us, we are confident that their publication will place scientific workers in Europe as well as America under a debt of gratitude to Ohio, and we trust they will not be withheld.

It appears that when the first volume of the Final Report was ready, the Legislature ordered that the edition should consist of four times the number of copies estimated by the chief geologist as likely to meet the public demand. It is to be hoped that a similar spirit will induce them to complete the Survey's publications. A survey by four geologists, in three years, of a country one-third larger than Scotland, must soon have been felt to be impracticable, more especially if it was meant that the whole of the surveyor's labours, writing as well as field work, were to be compressed within the three years over which it was originally planned that their salaries were to be continued. A conscientious desire to finish their work having kept the officers of the survey in the field (doubtless with the approval of the legislature) for two years beyond the estimated time, the results of their zeal and skill ought not to be thrown away. There need be no hesitation in admitting Prof. Newberry's assertion, when he "claims" "that an honest and energetic use was made of the time and money expended on the Survey, and that its fruits will be worth much more than their cost to the people of Ohio."

We must refer the reader to the Reports themselves for the valuable information with which they are crowded. We can only notice briefly the leading scientific results, and some points of more than usual interest.

The rock-formations exposed in Ohio form an almost unbroken series, ranging from Lower Silurian to Carboniferous, inclusive. The principal feature in the geology of Ohio is undoubtedly the "Cincinnati axis," and to this the late Survey has justly devoted much attention. This great arch, passing through Cincinnati and the west end of Lake Erie, brings to light the oldest rocks of the State. It has hitherto been understood to be a minor flexure of the same date as the elevation of the Appalachian chain, to which it is, roughly speaking, parallel. But the investigations of the recent Survey have proved it to be much older. While the Appalachian chain does not appear to have been elevated until after the Carboniferous epoch, Prof. Orton has made the discovery that a large portion of the Cincinnati region was a land-surface, and suffered erosion towards the close of Lower Silurian times. The denudation of a synclinal arch and consequent exposure of deep-seated strata would not, of course, alone suffice to prove this; but the insular character of the Lower Silurian land of Cincinnati is rendered certain by the occurrence of pebbles derived from it in conglomerates at the base of the Upper Silurian deposits, and by the manner in which calcareous strata of that age, as as well as some Devonian limestones, thin out on approaching what must have been the shores of the island. It is not so clear whether the island was or was not entirely submerged in Devonian and Lower Carboniferous times. On the other hand, Prof. Newberry and his colleagues have satisfied themselves that during the deposition of the Upper Carboniferous or Productive Coal-measures, the Cincinnati land formed a barrier between the marshes of Ohio and Indiana ; in other words, that the Alleghany and Illinois Coal-fields were never united, at least as far south as Alabama and Arkansas, where wide-spread tertiary deposits obscure all evidence bearing on the point.

"It is important," says Prof. Orton, "to mark the following fact distinctly, viz., that there is quite a broad tract at the summit of the fold in which the beds have but little dip. It is hard to speak of an axis without involving the idea of a line, but there is probably no part of this region of less than a score of miles that deserves, by way of excellence, the name of the Cincinnati axis. In other words, this fold has a broad and flat axis, rather than a linear one." The elevation has been so gentle and so gradual that direct visible evidence of unconformable succession is hardly to be expected.

No reader will fail to be struck by the important place accorded to chemical geology in the Reports. This portion of the work has been done mainly by Prof. Wormley, and adds greatly to the value of the survey as a whole. He has not confined his investigations to minerals of immediate economic importance, but has placed on record many analyses that must for a long time to come be drawn upon with advantage as the development of the resources of the State goes on. Especially as regards limestones and cement-stones and the amount of sulphur in the various coal-seams, very complete and useful information is given.

More than a score of counties "lie wholly within the limits of the productive coal-measures," and of nearly as many the geological surveyors pronounce without hesitation that "the soil will necessarily always be the source of their greatest material wealth." It sounds strange to hear already from such a rich agricultural district as Western Ohio the cry of exhaustion of the soil, but as all the surveyors without exception sound the note of warning against unskilful farming, it is evident that ere long science will have to be called in to assist nature if the productiveness of the State is to be maintained.

Although doubtless to be discussed more fully in the volume on economic geology, the coal and ironstone seams of the great coal-field, and the salt, oil, and gas industries receive much attention in the various county Reports. Prof. E. B. Andrews furnishes a chapter on coal which is full of interesting facts. Mr. M. C. Read gives a plan of a coal-mine in Trumbull County, which shows how very local was the formation of the seam. The coal thins out on every side, and presents the outline of a long winding swamp with branching creeks.

The importance of the ironstone beds in Ohio is well known. A black-band in Tuscarawas County locally attains, according to Prof. Newberry, a thickness of 12 feet.

The excitement caused by the discovery of the oil-wells of Pennsylvania and Ohio will yet be fresh in the memory of our readers. The conditions under which petroleum occurs are well illustrated in the Reports. There must be a mass of carbonaceous shales from whose organic contents the hydro-carbons are slowly distilled, and an overlying porous rock for the storage of the products—best of all a jointed sandstone with an impervious stratum for a roof—if dome-shaped so much the better. When these conditions are present the oil is ready for the fortunate landowner, and his luck is the greater if he happen to strike a joint where a quantity can collect. So well is this now understood that when a well shows symptoms of giving out, a torpedo is exploded in it to loosen up the rock and open out the way to neighbouring fissures. Carbonaceous shales, yielding oil, are met with at various horizons from the Huron (Devonian) upwards.

Carburetted hydrogen gas occurs under similar conditions and is now expressly bored for. The town of Fredonia, N.Y., has been lighted up with natural gas for more than forty years. In Knox County, Ohio, two wells were sunk to the Huron shale. "At a depth of about 600 feet, in each well, a fissure was struck from which gas issued in such volume as to throw out the boring tools and form a jet of water more than 100 feet in height. . . . One of these wells constantly ejects, at intervals of one minute, the water that fills it. It thus forms an intermittent fountain 120 feet in height. The derrick set over this well has a height of 60 feet. In winter it becomes encased in ice, and forms a huge translucent chimney, through which, at regular intervals of one minute, a mingled current of gas and water rushes to twice its height. By cutting through this hollow cylinder at its base and igniting the gas in a paroxysm, it affords a magnificent spectacle, a fountain of mingled water and fire which brilliantly illuminates the icy chimney. No accurate measurement has been made of the gas escaping from these wells, but it is estimated to be sufficient to light a large city." Unfortunately there is no large city to light.

Geologists had a right to expect from Ohio an important contribution to their knowledge of the Glacial period, and Prof. Newberry and his colleagues have not disappointed them. The chief geologist sums up the results of the Survey in a masterly essay, and it is satisfactory to find that his views to a great extent corroborate the conclusions at which glacialists in Europe have arrived. Want of space compels us to allude to these in the briefest manner. The cold came on at a period when the land stood considerably higher than at present, as is proved by numerous river channels deeply buried beneath the drift. A wide-spread boulder clay or hard-pan, the product of a land ice-sheet radiating from the Canadian Mountains marks an early, and the greatest, development of the cold. A subsidence followed on the retreat of the ice-sheet, and a stratified clay was deposited over low-lying portions of the hard-pan. Then a forest covered a large portion of the glacial *débris*, and this furnishes remains of the mammoth, mastodon, and giant beaver. Another submergence covered the forest-bed with the loess of the Mississippi Valley, and icebergs strewed boulders from Canada over the State. Much of the older drift was reassorted and heaped up into kaims or eskars. Lastly, the sea gradually retired, occasionally pausing, and giving rise to terraces in the river valleys.

Intimately connected with the Glacial period were the hollowing out of the great lake-basins, and numerous important changes in the drainage-system of the continent. Taking Lake Erie as the simplest case, it is clear that its basin was not excavated during the greatest extension of the ice-sheet, which, as shown by the striæ on the higher ground, passed directly *across* the valley. But in the bottom of the valley the striæ point *up* the lake, and this fact makes it probable that the excavation of the basin was the work of local ice, in other words, that it dates from a time when the valley-glaciers had ceased to coalesce. The islands near the upper end of the lake are wrought out of hard Corniferous sandstone and Waterlime exposed on the crown of the Cincinnati anticline. This hard barrier, Prof. Newberry believes, opposed an obstinate resistance to the passage of the glacier, and was consequently left in comparative relief.

The Ohio geologists without exception appear to be sub-aërialists, and indeed, the scenery of the State—such as it is—could hardly admit of any other explanation. It would not be easy to connect valleys of some hundreds of feet in depth with faults of less than a yard.

Of the palæontology of the Reports, we need only say that it is a remarkable proof of the enthusiasm, energy, and success of the late Prof. Meek and the naturalists who assisted him, several of them without any compensation. The publication of the Survey as a whole marks an epoch in culture as well as in material progress, in which all the well-wishers of the State must rejoice.

OUR BOOK SHELF

History of Nepāl. Translated from the Parbatiyā, by Munshi Shero Shunker Singh and Pandit Shrī Gunānand. With an Introductory Sketch of the Country and People of Nepāl, by the Editor, Daniel Wright, M.A., M.D. (London, Cambridge Warehouse; Cambridge, Deighton, Bell, and Co., 1877.)

THE Cambridge University Press have done well in publishing this work. Such translations are valuable not only to the historian but also to the ethnologist; perhaps more so to the latter than the former, as the very myths with which a people are apt to adorn their own history may become, in the hands of a cunning ethnologist, a clue to their racial connections. Dr. Wright's Introduction is based on personal inquiry and observation, is written intelligently and candidly, and adds much to the value of the volume. The coloured lithographic plates are interesting.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The First Swallow at Menton

THE first swallow arrived here alone in the rain on Monday, March 19. It entered the best room of the *curé* by one of the windows which chanced to want a pane, and the good old man immediately removed a pane from the other window, by which the swallows have been in the habit of going in and out. I did not hear of the arrival of this summer resident until the 23rd, when I immediately paid it a visit. It is still solitary but not uncomfortable; it flits about the room from place to place, and from nest to nest, twittering very contentedly; and when a bright hour comes it flies out, where, sporting in the sun it soon makes a hearty meal. But it has arrived decidedly too soon, for it has found as yet mostly wet and rather cold days with snow-covered mountains for its immediate surrounding. Such, however, is the climate of this place, difficult to conceive by untravelled Englishmen, that I at this moment bask outside in the sun, soothed by the singing of birds, surrounded by flowers and butterflies, and the green trees with their golden fruits. I am in the midst of summer, and yet I have but to turn my head, and there, close at hand, are the mountains white with snow.

The coldest weather we have had this winter began with this month. The only time I have seen ice was on the morning of March 1. (On the preceding night, I see by a letter to NATURE, vol. xv. p. 399, that the thermometer at the Stonyhurst Observatory went down to 9°·1 F., the lowest temperature there recorded during the last sixteen years.) That morning, cheated by the serene stillness and the bright sunshine, I, before getting out of bed, resolved to make a journey to the sea-side—a distance of about three miles. A lunch was immediately packed up and the donkey of the *curé* borrowed for the occasion. As soon as I descended into the valley—Cabrolles, consisting of some dozen houses, all the dwellings of peasants, and hung on the mountain side like so many birds' cages or birds' nests on the back wall of a court, open only to the south, is 300 feet above the level of the sea, and enjoys a climate superior to that of the much-vaunted Menton. I am, however, the first *étranger* who has ventured to brave the isolation, the inconvenience, and want of accommodation.—Well, as I have said, on descending into the valley, a change of temperature suggested that it would be preferable to have my Italian cloak around me, instead of carrying it before me on the donkey. Proceeding a little farther, I saw with astonishment large quantities of ice in the torrent, and in turns of the road looking northward, icicles, thick as my arm—which, however, is one of the thinnest—hanging from the rocks. Still I went forward quite irrationally, carried along solely by the force of the impetus with which I started, for, as I approached Menton, I had to make way in the face of a biting cold wind. But I would certainly have shivered over my cold lunch among the rocks or ruins at Cap Martin, had not my progress received a check at Menton, in the for the moment irritating discovery that the key of the provision-bag had been, I may now say providentially, lost. I accepted the hospitality of a kind English clergyman, who gave me a nice warm lunch, after which I slowly wound my way back to my mountain retreat, where I dwell almost as completely removed from the winter visitants of these shores as is the now lonely swallow from its companions, the summer visitants, which have not unwisely made a halt somewhere by the way.

After this long digression I must return for a moment to the swallows of Cabrolles. They live in the rooms with the people, attaching their nests generally to the beam which supports the ceiling. On their arrival, whether it be by night or by day, they enter at once and take possession of their old habitations. Madame Valetta, an old woman of seventy-three, has two or three times given me a graphic account of how, when she was a young woman and had her husband by her side, they were both frightened almost to death one night by something which from time to time gave a flap-flap against the glass of the window. Madame, however, summoned courage to urge her husband to get up and open the window, which, though "all of a shake," he did, when whish! very like a spirit, a weary swallow glided past him and was the same instant peacefully reposing in its nest. DOUGLAS A. SPALDING

Cabrolles, près de Menton, France,
March 24

Coal Fields of Nova Scotia

IN his address to the Iron and Steel Institute (NATURE, vol. xv., p. 462), Dr. Siemens stated that the area of the Coal Fields of Nova Scotia was 18,000 square miles, and the production in 1874 1,052,000 tons. If Dr. Siemens will refer to Dr. Dawson's "Acadian Geology," the Reports of the "Canadian Government Geologists," and Brown's "Coal Fields and Coal Trade of Cape Breton," he will find that he has greatly overstated the area of the Nova Scotia Coal Fields. From these sources, which I believe are perfectly reliable, I make out that the whole area of the Nova Scotia Coal Fields does not amount to 1,000 square miles, distributed over the following counties:—

	Square Miles.
Cumberland	250
Picton	34
Cape Breton	194
Victoria	6
Inverness	40
Richmond	10
	534